NAEB ENGINEERING
COMMITTEE
REPORT #3

OPERATING TECHNIQUES FOR VIDEO RECORDERS

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JULY, 1953

NATIONAL ASSOCIATION OF
EDUCATIONAL BROADCASTERS
14 GREGORY HALL, URBANA, ILLINOIS

(Engineering Committee Report Number 3)

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EQUIPMENT USED:

General Precision Laboratory - Video Recorder Model PA-300

General Precision Laboratory - Rapid Film Processor Model PA-401

J. A. Maurer Inc. - 16 MM Sound Recording System Model 61

Measurements Corporation - Intermodulation Meter Model 31

Weston Electrical Instrument Corp. - Photronic Photoelectric Cell Model 594

Simpson Electric Company - Microammeter (50ua f.s.)

Eastman Kodak Company - Densitometer Model 1A

*Bell & Howell Printer Model J

*Eastern Development Laboratories Processor

*Equipment used by Visual Aids Production Department

THE POSITIVE SOUND TRACK

Producing a good single system sound track is perhaps one of the simpler tasks the television recording engineer undertakes. We have experienced little difficulty in producing a good sound track on an original positive recording.

The method used is one of selecting on operating point for minimum intermodulation distortion. The generator section output of an intermodulation meter is fed into the recording amplifier. A modulation level of 80% is maintained throughout the test. Using different levels of current for the exciter lamp in the camera, and noting the specific values used, a series of lamp current steps is thus recorded. The test film is then given normal positive development. By connecting the analyzer section of the intermodulation meter to the output of a projector sound system, the operator is able to determine which lamp current value results in the least intermodulation distortion. If the series of lamp current values used in making the lamp current tests does not result in high-minimum-high distortion readings, the operator has picked the improper range. The test must then be repeated using a new range of lamp current values.

In practice, we have found the lamp current range is generally 1.5 to 2.0 amperes. This, however, will vary with film stock used, processing, lamp age, and the individual recording amplifier. Our minimum overall intermodulation distortion, in most cases, is below 10%. This will vary with the individual equipment used. It has been noted that minimum distortion is one particular and specific lamp current value. In making the test, therefore, small steps of lamp current are recommended, preferably .025 amperes.

We should like to add that this point of operation, once determined, will not remain constant, due to the ageing of the exciter lamp. The positive intermodulation test has become a weekly test and is also run prior to the usage of a new film batch.

In the immediate future we hope to add a binaural compensation unit to our sound recording system. It is hoped that this unit will insert the "presence effect" so lacking in almost all recordings. This desired addition does not mean that the present tracks are technically imperfect, or unsatisfactory, but rather that we wish to add the spatial perspective lacking in monaural sound. This unit will be "home-built" and made a permanent addition, should its merits meet our expectations.

EXPOSING THE POSITIVE PICTURE

Determining the optimum levels of exposure cannot consist merely of one series of tests, since one setting will affect another. In addition, many limiting factors are present where the operator is forced to retrace his steps and alter a setting he has previously determined as optimum.

One of the limitations present is the peak composite signal level the equipment will accomodate without signal compression and non-linearity. To determine the peak composite signal input possible without compression is a simple matter. Saw-tooth voltage is fed into the equipment at the distribution amplifier's normal 1.5 volt output level. The composite gain control is increased until compression is visiable on the recorder's signal monitor. Composite gain is decreased until compression is eliminated. We have marked this position, and composite gain settings never exceed this point.

A further limiting factor is the photographic tube's maximum grid signal swing. The manufacturer recommends a peak signal of 30 volts at the grid. A signal of one volt of our signal monitor represents seven volts on the kinescope's grid, or a ratio of 7.1. Since the maximum grid signal is to be 30 volts, the maximum video level on the signal monitor is approximately 4 volts. Should the film require greater exposure, a larger iris opening is used (since a negative image is being photographed).

To determine the point of optimum focus, we use another film test. The anode voltage is set at the manufacturer's recommended 25 kilovolts, after being brought to a point of table operation by a warm-up period. A normal recording image is set up on the photographic monitor. After checking interlace, and electronically focusing for scanning line predominance, a series of exposures using various focal lengths is recorded. After normal processing, a microscope is used to determine which focal length setting has resulted in scanning line reproduction over the entire image area. Recorder focus for each recording is considered good if scanning lines are present in the projected image.

The television film chain will handle satisfactorily a film density range of .15 to 2.0 without compression or edge flare due to high film densities. We therefore attempt to place maximum density in the range of 2.0. The bias used, along with the iris setting, determines the greater film density. Minimum f stops are avoided since this gives a minimum depth-of-focus. In addition, we consider the control of video and set up of the image, throughout the production, the responsibility of the video operator. Therefore, in determining the bias setting required for the desired 2.0 density, the set-up control is set at "set-up full in". Video gain is at zero, tube is at optimum focus and anode voltage is at the recommended stable 25 kilovolts.

As a method for controlling and determining the density range, we have constructed a Gray Scale Generator. This unit will generate a series of linear voltage steps which we use to expose the film for test and control purposes. At present five steps of voltage are used, since any greater number would result in wedges so small they could not accurately be read on our present densitometer. By placing the top step at various peak video levels, we can determine what peak video level is required to give the other end density of a .15 on the reproduced image. This series of step wedges is exposed immediately after recording a production on the same roll of film. The top step is placed at the peak video level

used in recording the production and the bottom step is placed at the blanking level. We therefore have a means of measuring the density range recorded on the film, and can more accurately determine the source responsible for poor quality recordings.

The gray scale recorded at the end of each production is closely watched for indications of photographic tube aging. A decrease in density means a decrease in the tube's light output efficiency and can be compensated for by changing iris and bias settings.

EXPOSING THE NEGATIVE PICTURE

All of the equipment limitations set up for recording the original positive apply to recording negative film. A 30 volt maximum grid signal, 4 volt maximum monitor level, the same maximum composite signal input, and same vacuum all apply to recording negatives. The focal length, of course, remains the same, but becomes more critical.

We are using Eastman 7373 negative film stock, especially designed for video recording for all negative recording. It has been found necessary to use a minimum lens setting of f 1.6 to obtain sufficient exposure without forcing the tube into the"blooming" and defocus stage.

After plotting the light output characteristic curve for the photographic tube (1CNP11), we have determined that a density range of .35 to 1.3 is permissible on the negative, in order to operate on the tube's most linear light output portion. Going beyond this portion results in tonal compression. A density range of .35 to 1.3 also fits easily into the linear portion of the Eastman 7373 characteristic curve.

Bias settings for negative recording are determined in a manner similar to that positive recording. However, since the recorded image is negative, bias settings determine the low density end rather than the high density end. In other words, the bias setting now determines the .35 density.

The gray scale again proves invaluable in determining the video level necessary to bring picture hi-lights to a negative density of 1.3. Gray scale exposure is recorded at the conclusion of the individual production recorded. It serves as the control procedure for determining print exposure.

DEVELOPING THE EXPOSED NEGATIVE

The recommended control gamma of Eastman 7373 is .5 to .7 which should not be difficult to achieve in most commercial developing machines. We are equipped with a rapid processor not especially designed for processing negative film. To be able to use the rapid processor for negative film development means better quality control and faster print service. In figure 1 is a plot of Eastman 7373 control gamma curves at various chemical temperatures. The curve shown for 110 degrees results in the most linear curve at a gamma of .6 and so closely resembles that of most commercial processors designed for negative film development, that we have considered it satisfactory.

PRINTING THE NEGATIVE

The curves plotted in figure 2 are the key in our present method of determining accurately and quickly the proper printer exposure lamps for the picture and sound track. A negative sensitometric strip of Eastman 7373 emulsion was processed with the rapid processor at 110 degrees. This strip was then printed at the various printer lamps indicated and given the recommended 2.5 control gamma development. After reading the negative densities and each printer lamp densities, sufficient dynamic data was obtained to plot a family of negative-print response curves. This, then, is not merely a theoretical graph, but actually a working graph which has proven a satisfactory method for obtaining correct prints at the first printing.

The gray scale which follows the close of each production will indicate what the recording's contrast range is and where it lies. By consulting the

negative-print response graph the operator can determine which printer lamp will result in the desired.15 to 2.0 print contrast. We have also supplied our Visual Aids Department with an identical copy of this graph. This enables the printer to follow our controls and check his print exposures and print processing.

Along with the gray scale, we also expose an unmodulated unbiased section of sound track to serve as the control point for printing variable density sound track. By reading this density on the negative and referring to the negative-print response curves, the printer can again accurately and quickly determine the printer lamp to be used in printing the sound track.

Should the printer require a new print lamp, a new family of negative-print response curves must be plotted. This, however, is not difficult and can be accomplished in a short period of time to avoid printing delays.

To check the photographic process is merely a matter of checking densities of the gray scale on the resultant print. By using this gray-scale-density check system, we are able to follow the complete photographic process and determine what source is responsible for low quality prints. Since many variables exist, it would be difficult to locate the source of trouble with fewer check and control points in the system.

The vacuum used in recording was determined by recording images at various vacuum levels. By projecting the reproduced image, with the framing line visible, the vacuum resulting in minimum "jutter" is used. This is not a critical setting.

Construction of a phase and aperture corrector is now under way. The purpose of this unit is to reduce image phase distortion and compensate for losses of high frequencies to improve contrast in fine image detail.

The film manufacturer's recommended process control gamma of 2.5 is used in processing all original positive film tests and recordings. The rapid processor's chemical temperatures are all at the recommended 120 degrees for processing positive film.

EXPOSURE COMPARISON

An addition to the recorder has been the mounting of a photo-electric cell in front of the photographic tube and the connecting of this cell to a microammeter. This device then actually becomes an exposure meter since it is measuring the average light radiated by the photographic tube's phosphor. By logging the microammeter's reading for each recording, the operator soon establishes a range of readings for each type of picture recorded and can tell, during the rehearsal or camera set-up period, if the recording will have the proper exposure. Should readings be above or below average, the lighting department and video operator can check scene illumination and camera set-up for proper levels. This is also a good method of checking studio camera balance.

SOME COMMON DIFFICULTIES ENCOUNTERED

Film Scratches- After checking for scratches throughout the processor, it was discovered that these scratches were coming from the recorder camera. Further, checking revealed that dirt had collected in the magazine light trap and caused the scratching. After disassembling the light trap and thoroughly cleaning it the scratches disappeared.

Film Scratches- Most film scratches come from squeegee rollers between chemical tanks. Mineral deposits from the wash water collect in these squeegee chambers and are not flushed out when the processor is cleaned by flushing. It has become standard practice to remove these chamgers and rollers and clean thoroughly before each processing period begins. The addition of a water softener unit may eliminate this difficulty.

Improper Aspect Ratio-The earlier method for determining optimum sweep size on the photographic tube, by recording a calibrated picture and projecting it, proved inaccurate. Inmost cases, the projector used to view the test had an aperture mask which was off center and thus the improper calibration marks were selected as the optimum sweep size. The present method is to eliminate this

inaccuracy by checking the film frame under a microscope and picking the last visible calibration marks for optimum sweep size. A 1/8 inch buffer area is added to all four sides of the picture to compensate for any small errors in centering and photographic tube movement.

Insufficient RecorderVertical Sweep-Vertical Sweep Deflection Chassis plate voltage was 250 volts. Diagram listed plate voltage at 250 volts or 330 volts. After checking power supply specifications, it became obvious that it would handle this additional load easily. Plate voltages were increased to 330 volts and vertical sweep increased well beyond that required.

Excessive "Join-up" Line Appearance - This trouble occurred after installing a new camera claw. After closely examining the claw clearances, it was noticed that the claw was actually striking the film on "non-pull-down" cycles. The claw had been improperly machined and had to be replaced.

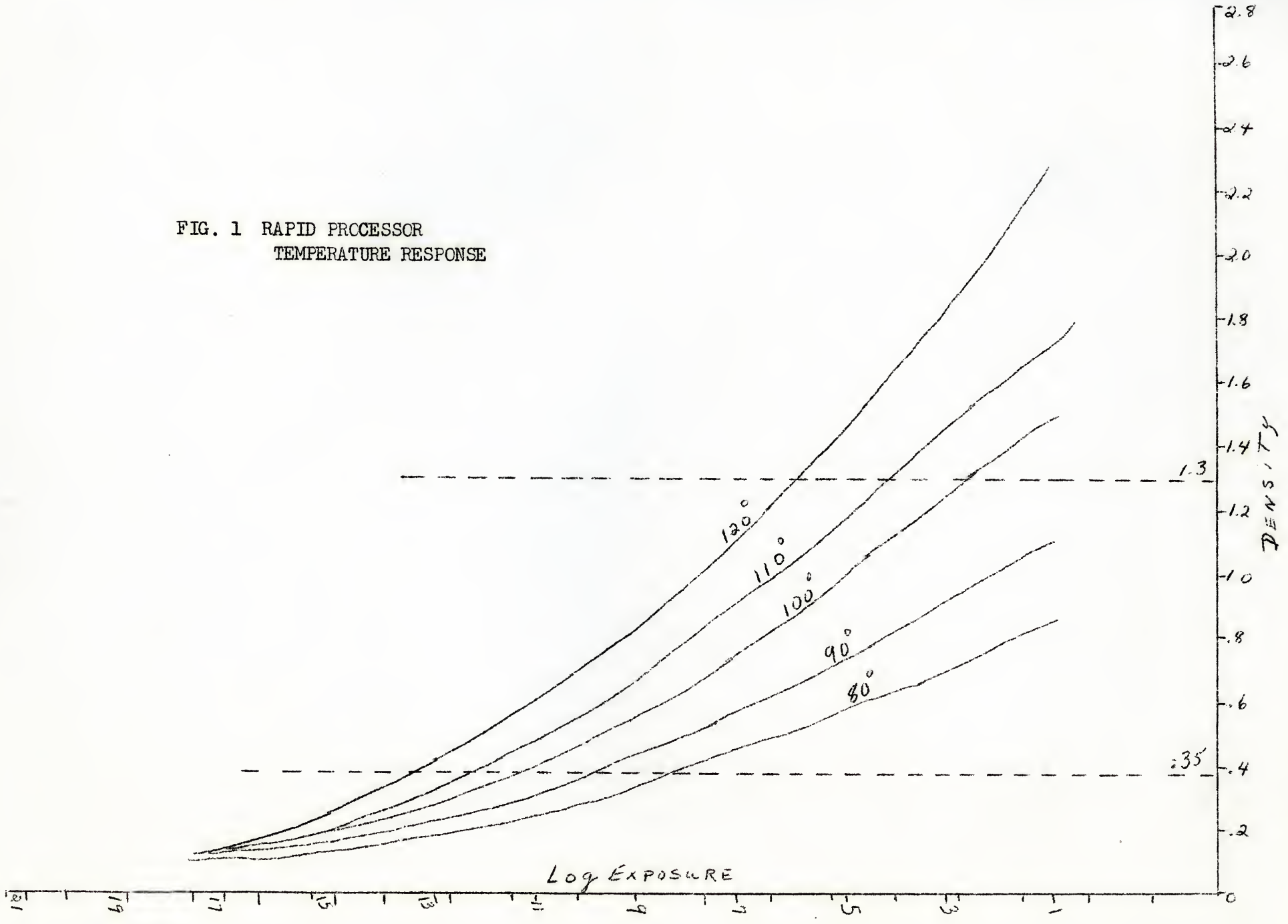
Flicker At "Join-up" Lines - After running various shutter correction voltage tests, the manufacturer was consulted and among a list of possible causes was one of worn film guide roller bearings in the film gate. New bearings were installed and aligned with the aid of an alignment jig furnished by the manufacturer. This eliminated the flicker.

Loss of Film Loops In the Camera-This was a matter of improper film take-up tension. After lubricating the friction discs in the take-up mechanism and lessening tension, loops stayed in place.

Improper Film Tension Through The Rapid Processor- After futilely attempting to obtain proper film tension by adjusting roller clutches, it was discovered that film pulleys were binding and not acting individually. Chemical deposits carried into the drying chamber on the wet film left an abrasive layer on the outside surfaces of these pulleys and caused them to act as one six-section pulley instead of six individual pulleys. This effect applies to the non-driven as well as the driven pulleys. Pulley surfaces, therefore, must be cleaned before practically every processing period to obtain proper tension.

Overheated Chemicals- This became more of a problem as lower temperatures for negative processing were desired. A system of cold water sprays at the rear of the chemical spray chambers was installed. This permitted temperature regulation by varying the force of the cooling spray. Reticulation is also avoided.

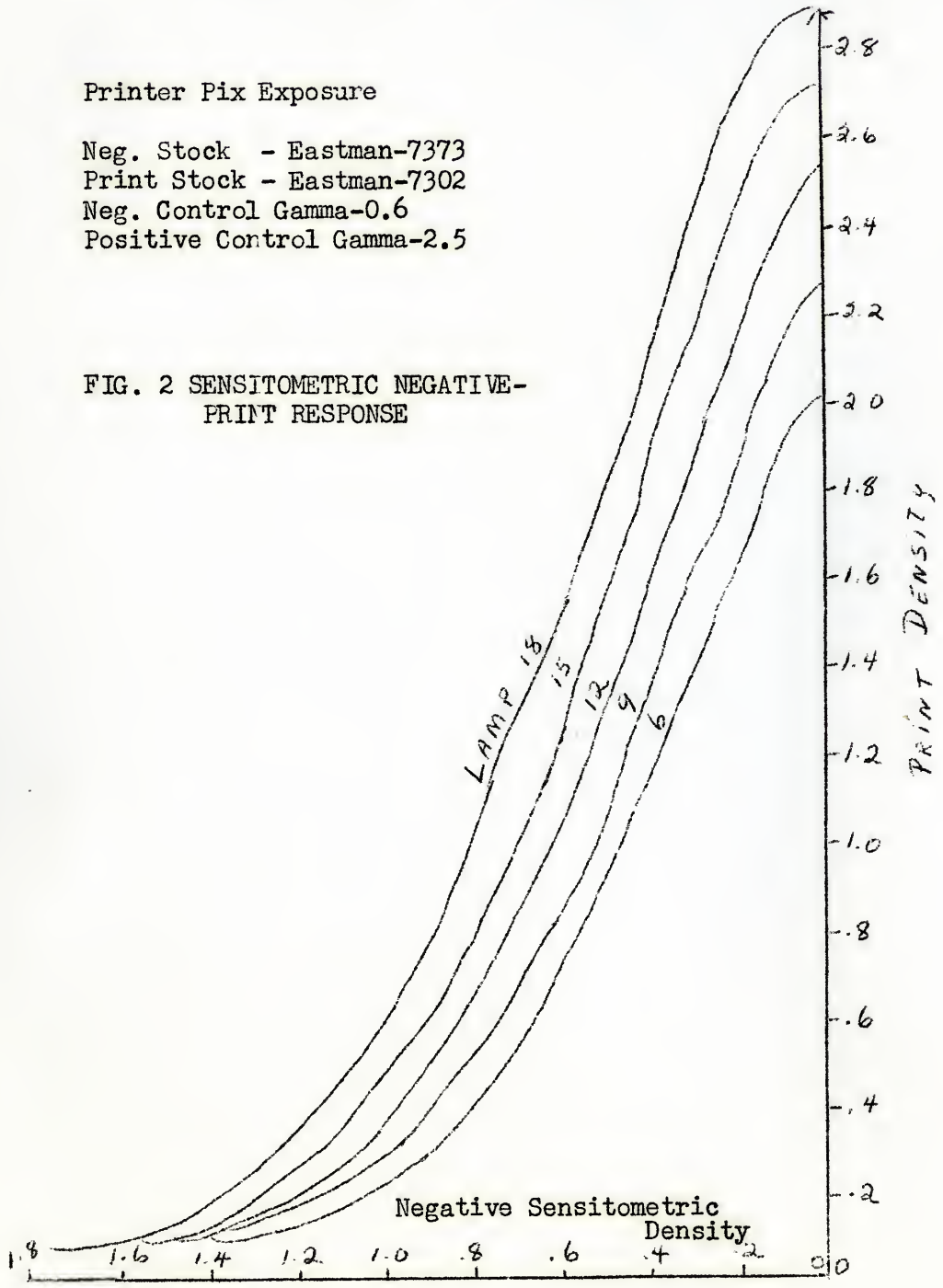
FIG. 1 RAPID PROCESSOR
TEMPERATURE RESPONSE



Printer Pix Exposure

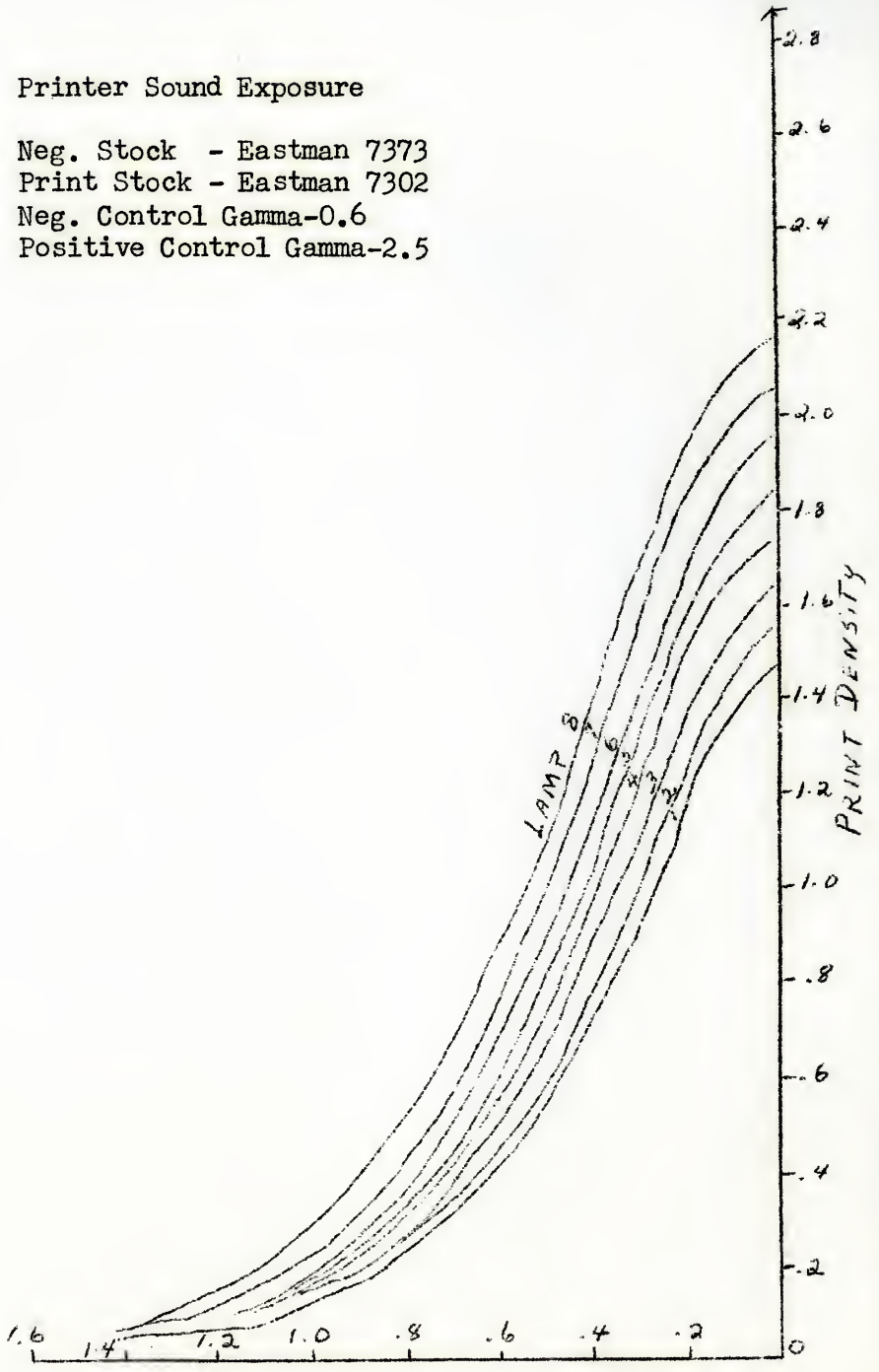
Neg. Stock - Eastman-7373
Print Stock - Eastman-7302
Neg. Control Gamma-0.6
Positive Control Gamma-2.5

FIG. 2 SENSITOMETRIC NEGATIVE-PRINT RESPONSE



Printer Sound Exposure

Neg. Stock - Eastman 7373
Print Stock - Eastman 7302
Neg. Control Gamma-0.6
Positive Control Gamma-2.5



Scanned from the National Association of Educational Broadcasters Records
at the Wisconsin Historical Society as part of
"Unlocking the Airwaves: Revitalizing an Early Public and Educational Radio Collection."

A collaboration among the Maryland Institute for Technology in the Humanities,
University of Wisconsin-Madison Department of Communication Arts,
and Wisconsin Historical Society.

Supported by a Humanities Collections and Reference Resources grant from
the National Endowment for the Humanities

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